



Fennel: More Than Herb, Unveiling its Traditional Uses, Phytochemistry and Medicinal Properties

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ABSTRACT

Fennel is considered as one of the oldest medicinal plants and culinary herbs. It's in use since 4000 years. It is a biennial plant with a thick rootstock, erect, much-branched, and smooth, often 1 meter or more in height. It probably occurs in Southern Europe and the Mediterranean region. It is grown as a spice, medicine or essential oil plant or vegetable in many parts of the world and has been naturalized in many places.

This review aims to give an outline of medicinal aspect of *Foeniculumvulgare* Mill focusing more on its traditional function and uses.

The literature search encircled scientific databases, publications and ancient Unani literature books for traditional usage, chemical profiling, and pharmacological activities and so on.

Foeniculumvulgare Mill displays various pharmacological activities like estrogenic activity, gastro protective activity, hepato-protective activity, antidiabetic activity, cardiovascular and lipid activity, antithrombotic activity, antioxidant activity, anti-inflammatory activity, anti-bacterial activity, anti-anxiety potential, memory protective potential. The plant contains Essential oil / Volatile oil, Coumarin, Fixed oil, Cinnamic acid derivatives, Sterols, Saponin, Flavonoids glycosides, Quercetin and Vitamin. In traditional system of medicine it is used in flatulence, kidney stones, bronchitis, diabetes, and persistent cough. It is also used as diuretic, emmenagogue, improving eye sight, in wound healing, increases breast milk and semen production. It has properties of *Mudirboul-o-hayz*, *Muqawwi-e-basar*, *Muqawwi-e- meda*, *Muwallidmani*, *Muwallid sheer* etc.

Foeniculumvulgare has emerged as a good source of traditional medicine and has been used in different ways due to its phytochemical constituents and easy availability. Further research is needed to validate its potential, mechanism of action for the development of new drugs and future clinical uses.

Key Words: Saunf, *Foeniculumvulgare*, *Badiyan*, *Mudirboul-o-hayz*, *Unani*, Herb

INTRODUCTION

Foeniculum vulgare is usually a perennial, aromatic plant belonging to *Apiaceae* (*Umbelliferae*) family with many subspecies and varieties.¹ It is a hardy, perennial-umbelliferous herb with yellow flowers and feathery green leaves.² It is found not only on the shores of Mediterranean sea but also located on dry soil around river banks.³

The literature search was carried out to collect all relevant data on fennel through publically available electronic databases including PubMed, Google scholar, Scihub, science direct and other internet sources. Additionally, the material was compiled using books that were published in both Urdu and English as typical literature in Unani medicine.

The keywords for the search included “fennel”, “*Foeniculum vulgare*”, “*Badiyan*”, “*Saunf*”.

The review article is aimed to discuss the traditional uses and functions, ethnobotanical description, phytochemistry, chemical constituents of fennel. Additionally it delved into the pharmacological actions of fennel focusing more on the Unani aspect of the herb.

Fennel plants have a long history of use in herbal remedies, treating a wide range of ailments. They are beneficial in treating persistent fevers, liver, digestive, respiratory, and urinary disorders, vision-related disorders, stomach ailments, hormones, reproduction, and digestion. Fennel is also known to enhance lactation and prolactin levels in nursing

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women and is used as a natural remedy for anxiety and mental health issues.⁴

The aim of the review article is to provide a valuable, informative and critical summary of existing literature on fennel.

Its serves a purpose of providing both traditional as well as modern aspect of fennel under one roof.

MATERIAL AND METHODS:

Due to its commercial significance and extensive occurrences in dry and semi-arid regions, fennel is considered the oldest spice plant and it is among the most powerful medicinal herbs in the world.⁵ Some authors distinguish two sub-species of fennel, piperitum and vulgare. Sub-species piperitum has bitter seeds, while sub-species vulgare has sweet seeds which are used as flavouring agents in baked goods, meat and fish dishes, ice creams, alcoholic beverages, etc. due to their characteristic anise odour. Morphological differences between these two sub-species are not always clearly defined.²

Synonyms: *Anethumfoeniculum* L. (1753), *Foeniculum Capillaceum* Gilib. (1782), *F. Officinale* Allioni (1785).⁶

Scientific Name: *Foeniculum vulgare* Miller

Common Name: - Fennel, Sweet fennel, Florence fennel.⁶

Vernacular names:

Arabic	Bisbas ¹ , Raziyanj ²
Persian	<i>Badiyan Darazyana</i>
Assamese	Guvamuri
Bengali	Mauri Panmouri
English	Fennel
Gujrati	Variyali, Variari, Warialli
Hindi/Urdu	Saunf
Kannada	Badi-sepu, Badi-sopu, Sabbasaige
Kashmiri	Saunf, Badana
Malayalam	Kattusatakuppa, Parijaeragum
Marathi	Badishep
Oriya	Panamadhuri
Sanskrit	Misi, Mishreya, Madhurika
Tamil	Shombu, Sokirie
Telugu	Sopu ⁷
Unani	<i>Madariyoon, Marsiyoon, Barhalea, Khoomarasoon</i>
Roomi	Shamar ⁸

Taxonomical classification:

Kingdom	Plantae
Subkingdom	Tracheobionta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Rosidae
Order	Apiales
Family	Apiaceae
Genus	<i>Foeniculum</i>
Species	<i>F. vulgare</i> ⁹

Mahiyath/description: It is a famous seed with fragrance which is greenish yellow in colour and sweet in taste¹⁰ and grow in bundle like soya or zeera.¹¹ It is a herb having *Jangli* (Wild) and *Bustani* (Cultivated) variety, later is considered the best.

Plant of *Jangli* (Wild) *sounf* is green in colour and it is smaller than *Bustani* (Cultivated). It is more than a meter in height, stem smooth and angular; branches thin, flowers in terminal umbels and are in yellow in colour; seeds ovalate, greenish brown in colour, aromatic, sweet, crowned, with five ridges on each side. If *Jungli sounf* chewed then tongue will anesthetised. *Jungli* seeds are bigger than *Bustani* seeds. Its leaves are like coriander leaves and as well as long as coriander leaves. Flowers of *Badiyan* are small and of white in color.¹²

Mizaj/temperament:

According to *Boqrath* it is *garm* 2nd degree *khushk* 1st degree.

Leaves fall in 1st degree *garm* category.

Beeq – *garm* o *khushk* 2nd degree.⁸

Garm-o-khushk.¹⁰

Af'al/functions:

- *Mufatteh sudda*^{7,8}
- *Mujaffif*
- *Mulattif*⁸
- *Dafa-e-muhallil riyah*^{7,8},
- *Qabiz*
- *Tiryaq*⁸
- *Mudirboul-o-hayz*^{7,8,10,11}
- *Muqawwi-e-basar*^{7,8,10,11}
- *Muqawwi-e-meda*^{7,8,10,11}
- *Munaqqi-e-rehem*
- *Muwallidmani*
- *Nafa-e-dard masana*⁸
- *Munzijsouda-o-balgham*^{7,8}
- *Muteeb dehen*¹¹
- *Muwallid sheer*¹⁰

- **Istemaal/Uses:** *Joshanda* of *beeq badiyan* is used in *balghami* and *soudawi amraz* to provide *nuzaj* to *khilt balgham* and *souda*^{10,11}
 - *Amraze aankh*: *Badiyan* improves vision especially *samagh badiyan*, it is beneficial in *nuzoolul ma*.
 - If juice of *berge badiyan* is mixed with *shehed* and *sakbeenj* and applied in eye using *silayi* it benefits in reducing yellowishness of eye and cataract.
 - If *tukhme badiyan* is burnt in earthen pot, powdered and sieved in cloth of *hareer* and then applied in eye as *silayi* it improves vision and is helpful in lacrimation
 - If *shehed* is mixed with *darkht badiyan ka khushk shuda ras* and applied in eye then it is beneficial in lacrimation in children⁸
 - *Amraz meda*: beneficial in *dard shikam*, *reehi*, *nafakh shikam*, and *zofe meda*.^{10,11}
 - *Safoof* of *badiyan* with *gulkhand* strengthens stomach and expels *balghami rutubat*.
 - Massage on stomach with *safoof badiyan* reduces stomach ache in children.⁸
 - It corrects chronic diarrhoea.⁵
 - *Badiyan* with *zeera safed* is effective in diarrhoea and strengthens stomach.
 - *Safoof* of *badiyan* with *aab sard* is beneficial in *iltehab meda* and *ghashiyan* occurring in fever.⁸
 - Emmenagogue and diuretic: *Joshanda* of *badiyan* is a strong emmenagogue.^{8,10,11}
 - *Badiyan barri* is good in *silsil boul* and expels morbid matter from uterus of postpartum women^{5,8}
 - *Tuqm badiyan* alone or used along with *jau* or *beeq badiyan* increases production of breast milk and semen.^{2,5,8,10}
 - *Amraaz raas*:
 - *Joshanda* of *tukhm badiyan*, *persiyaoshan* and *anjeer* is effective in cough, asthma, and difficulty in breathing.
 - It dissolves morbid matter of chest.
 - Wound healing:
 - Cleaning wounds with *Joshanda* of *Badiyan Barri* is beneficial.
 - *Zimad* of green leaves of *badiyan* helps in healing wound.
 - *Zimad* of *beeq badiyan* and *shehed* on wounds is effective.
 - Others:
 - *Joshanda* of *tukhm badiyan* and *gul gaozaban* is beneficial in *khafkhan* and *ghashi*⁸
 - It opens up obstruction of Liver and Spleen. Especially *badiyan barri* is effective in jaundice.^{5,8}
- Miqdar khurakh/dosage:**
5-7 gm^{7,8,10,11}
3-6 gm of dried fruit⁷
17.5 gm, 4.5-9gm
In the form of *joshanda* – 9-13.5gm⁸
- Muzir/adverse effects:**
Causes headache in few *garm mizaj* persons.⁸
- Musleh/corrective:** *Sandal safed*^{8,10,11}
*Kishneez*¹⁰
Kafoor, *zaroor*, *sikanjabeen*⁸
- Badal/substitute:** *Beeq karafs*^{8,10,11}
*Anisoon*⁸
- Nafa-e-khas/main action:** *Muqawwi Meda-o-basar*.¹⁰
- Murakkabath/compound formulations:**
Jawarish zaruni sada^{7,11}
Sharbat zufa murakkab
Halwa-e-chobchini
*Hab moghz badam*¹¹
Hab ghariqoon
Qurs mulayyan
Majoon muqil
Majoon musaffi-e-khoon
Majoon nankhawah
Roghan baladur
Arq badiyan
Arq juzam
Sikanjabeen bazuri motadil
Sharbat sadar
Sufoof hazim-e-kalaan
Safoof tabkheer^{2,7}

Habit and habitat: Native to the Mediterranean region; now cultivated primarily in Punjab, Assam, Maharashtra and Vadodara (Gujarat).^{1,2} *Foeniculum vulgare* Mill. is actually indigenous to the shores of the Mediterranean, extending eastwards, however is cultivated for medicinal use in the south of France, in Saxony and Wurtemberg in Russia and Galacia, and furthermore in India and Japan.¹²

Ethnobotanical Description: Fennel is a tropical herb that has been used and cultivated for centuries. The plant is characterized by many branches, soft leaves, and hairy-like foliage. It may reach a height of 2 m, and the foliage consists of 3–4 pinnate leaves. In addition, it has a slippery green stem and small yellow flowers (Figure 1). The fruit is elongated, and the seeds are greenish-yellow (Figure 1). They reproduce using their seeds or vegetative multiplication using their root fragments. Several studies have described this species as a perennial herb; however, some researchers have classified fennel as an annual or a biennial plant. Fennel seems to have a typical annual plant characteristic.¹³

Microscopic study of fruits: The rind has quadrangular to polygonal cells, the cuticle is smooth, and the fruit has several stomata in cross-section; trichomes missing; Fat tubes, dorsal fur, and two attachment points extend along the length of each shell. Epithelial cells in intercostal spaces. The skin cells are quadrangular or polygonal in shape, the cuticle is smooth, and there are few stomata in cross-section. No trichomes; Vittae, four ridges and two commissures, length of each ramus, intercostal, brown cell epithelium and lumen containing essential oil. Costae, 5 in each mericarp, each with one vascular strand with one inner xylem strand and two lateral phloem strands separated by a bundle of fibres; mesocarp, with considerable reticulate lignified parenchyma; inner epidermis with very narrow, thin walled cells organized in groups of 5–7 cells, many of these groups with longer axes of their cells an angle to those of adjacent groups (Parquetry arrangement); Carpophore with thick-walled, cellulosic parenchyma in two strands, often unsplit with two strands very close to each other; endosperm with thick walled, cellulosic parenchyma containing much fixed oil, micro rosette crystals of calcium oxalate, and numerous aleurone grains upto 5 m in diameter.¹⁴

Parts used: All parts are used.²

Seeds, *Beeq badiyan*.¹²

Medicinal Uses: For thousands of years, fennel has been used in traditional medicine to treat a number of diseases and has a long history of use by humans. Fennel was thought to have calming characteristics in the fifth century, and from the ninth through the fourteenth centuries, it was credited with a wide range of medicinal benefits. Fennel seed, according to the Romans, might enhance eyesight. The English thought that the herb may help with digestion and provide

comfort from a bloated stomach. Since the 18th century, fennel has been used therapeutically, and several research has been conducted.

The various plant components are now utilized to treat a variety of illnesses, including digestive system discomfort.

Additionally, it is highly effective in the treatment of kidney stones, bronchitis, diabetes, and persistent cough. Meals with cream use fennel seeds as an ingredient. The plant is used to treat kidney and bladder disorders because of its diuretic properties. It is also used to stop vomiting and ease nausea. The herbs are useful for treating chronic fever as well as obstructions in the hepatic, gastrointestinal, respiratory, and urinary tracts. In addition, they are utilized to treat conditions relating to the eyes, such as cataracts, and the stomach, such as persistent diarrhoea, endocrine, reproductive, and respiratory systems. In addition to that, it is also utilized in the treatment of breastfeeding women as a galactagogue agent.⁵

Chemical Constituents: The preliminary phytochemical study revealed the presence of saponins, flavonoids, cardiac glycosides, sterols, triterpenes, coumarins and volatile oils. It also contained protein, fat, minerals, fibre and carbohydrates. The minerals and vitamins identified in *Foeniculum vulgare* included calcium, potassium, sodium, iron, phosphorous, thiamine, riboflavin and niacin.

Triterpenes, flavanoid glycosides, smaller terpenes (monoterpenoids, sesquiterpenoids and diterpenoids) and reducing sugars were isolated from the seeds of *Foeniculum vulgare*.¹⁵

Pharmacological activities:

Estrogenic property:¹⁶ *Foeniculum vulgare* seed is used for polycystic ovarian syndrome (PCOS) treatment with phytoestrogen compound present in it. The reno-protective action of *F. vulgare* aqueous extract (AEF) in female rats with PCOS is examined. Forty female rats were divided into five groups. The first group worked as control, was injected with an equal volume (0.2 ml) of normal saline, and provided regular diet. Non-polycystic ovary syndrome (PCOS) rats in the second groups were treated with intra-gastric administration of *F. vulgare*'s aqueous extract (150 mg/kg b.w.). The intra-peritoneal injection of estradiol valerate (4 mg in 0.2 ml of sesame oil) was injected in the third groups. The fourth groups were treated with the same route using EV and AEF (150 mg/kg b.w.). EV and AEF (100 mg/kg b.w.) were administered to the fifth group. After 4 weeks of analysis, all the rats were sacrificed, the tissues extracted from Rat's kidney were processed for light microscopy, and some biochemical parameters of serum were calculated. The mean values of blood urea nitrogen in PCOS rats treated with low dose of AEF and EV and non-treated, were significantly increased as compared to non PCOS and PCOS rats treated with higher dose of AEF. Moreover histo-pathological improvements in

kidney samples were comparable in PCOS rats with respect to the treated groups with AEF.¹⁷

Gastro protective Effect:¹⁶ Pre-treatment with fennel water extract significantly reduced ethanol-induced gastric damage in rats, which was suggested to be due to reduction in lipid peroxidation and augmentation in the antioxidant activity. The water extract is reported to increase gastric acid secretion by more than three times of basal secretion in rats that was not blocked by atropine; but significantly reduced basal acid secretion in aspirin-induced gastric mucosal damage. Oral administration of essential oil and anethole is also significantly protective against ethanol-induced gastric lesions in rats. The antioxidant activity of phenol contents is partly credited for the anti-ulcer effects.¹⁸

Hepato-protective activity:³ The fennel essential oil has been reported to possess hepato-protective activity. In a study, the hepatotoxicity produced by acute CCl₄ administration was found to be inhibited by fennel essential oil with evidence of decreased levels of serum aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP) and bilirubin.¹⁹

Anti-diabetic Activity:³ A research study showed aqueous extracts from fennel, affected blood sugar levels and had anti-diabetic effects. The results showed that the extract might be helpful for diabetic patients to regulate blood glucose, and that regular usage could be successful in lowering chronic problems related to diabetes. A study was conducted on streptozotocin diabetic rats to test their blood sugar expecting its reduction after fennel use. According to the results, fennel extract reduces hyperglycaemias in diabetic rats, which is partly due to the herb's impact on the oxidation/restored system. Consequently, this plant can be utilised in the pharmaceutical industry to create anti-diabetic drugs²⁰

Cardiovascular and lipid activity:⁵ The study of the anti-cholesterol and anti-atherogenic effect of fennel methanol extract showed that treatment with the extract significantly reduced plasma lipid levels. Also the plant had important anti-atherogenic effects. It reduced triglycerides in fatty liver and facilitated blood flow in the coronary arteries by preventing the build-up of fatty deposit in arteries through reduction of plasma and liver fats. As a result because of hypo-lipidemic and anti-atherogenic activities, this herb could be used for controlling cardiovascular disorders. Also intravenous injection of the extract significantly reduced blood pressure, without affecting the heart rate and respiration. It seems that fennel extract effect on blood pressure was not mediated by adrenergic, muscarinic, ganglion, serotonergic receptors. In other study, oral administration of the extract reduced systolic blood pressure. The fennel extract acts as a diuretic and natriuretic, too.²¹

Antithrombotic activity:¹⁶ A review stated that the essential oil of *F. vulgare* and its main component, anethole has been

shown to have a safe antithrombotic activity that originates due to their broad-spectrum antiplatelet activity, clot destabilizing effect and vaso-relaxant action. Anethole, the main component of fennel oil tested in guinea pig plasma was as potent as the fennel oil in inhibiting arachidonic acid, collagen-ADP and U46619 induced aggregation. Anethole also prevented thrombin induced clot reaction at concentrations similar to fennel oil. The fennel oil and anethole were tested in rat aorta with or without endothelium and displayed comparable NO-independent vaso-relaxant activity at antiplatelet concentrations which have been proved to be free from cytotoxic effects *in vitro*. Furthermore, both *F. vulgare* essential oil and anethole (100 mg/kg oral administration) provided significant protection towards ethanol induced gastric lesions in rats.²²

Antioxidant activity:¹⁶ The antioxidant activity of wild, edible and medicinal fennels from different Mediterranean countries has been determined. Wild fennel has been found to exhibit a radical scavenging activity higher than that of both medicinal and edible fennels. The methanolic extract of *F. vulgare* fruit has also been reported to exhibit antioxidant activity by decreasing the malondi aldehyde level in *F. vulgare* fruit methanol extract group compared to the control group. The essential oil and acetone extracts of *F. vulgare* have been reported to exhibit strong antioxidant activity in comparison with butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT). The inhibitory action of oil and the acetone extracts in linoleic acid system was studied by monitoring peroxide accumulation in emulsion during incubation through ferric thiocyanate method. *F. vulgare* fruit extract and the purified compounds namely cis-miyabenol C11a-O-b-D-glucopyranosyl-(1f6)-b-D-glucopyranoside, cismiyabenol C, trans-miyabenol C, sinapylglucoside and syringing 4-O-b-glucoside have been reported to exhibit antioxidant activity. The n-BuOH extract of the *F. vulgare* fruit showed a moderate activity in the lipid peroxidation assay but strong activity at the higher tested concentration. Pure compounds isolated from *F. vulgare* showed higher antioxidant activity than the crude extracts.¹

Anti-inflammatory:^{5,16} Methanol fruit extract exhibited inhibitory effects against both acute and sub-acute inflammation and a central analgesic effect, and significantly increased plasma antioxidant enzymes activities and the HDL cholesterol level. Four coumarins isolated from the fruits showed excellent *in vitro* antioxidant activity and imperatorin had the greatest anti-inflammatory and antioxidant activities, inhibiting pro-inflammatory cytokines production, including interleukin-6 and tumor necrosis factor- α (TNF- α) in Lipopolysaccharides (LPS)-stimulated raw 264.7 cells. Essential oils from the aerial parts and fruits are also reported to inhibit 5-lipoxygenase enzyme¹

Anti-bacterial activity:^{1,5} Antibacterial Activity Sofi *et al.* reported that the aqueous and organic extract of *F. Vulgare* shows the antibacterial activity against some bacterial strains. The essential oil of *Foeniculum vulgare* has also been reported to possess antibacterial activity against some human pathogenic bacteria. Ethanol and water extracts of *Foeniculum Vulgare* have shown Antibacterial activity. Mahady et al. (2005), reported the chemical constituents from *Foeniculum vulgare* have been identified as active antimicrobial principles such as a phenyl propanoid derivative – Dillapional was found to be the active antimicrobial principle of the *Foeniculum vulgare* stem.¹⁶

Anti-anxiety potential:^{5,16} Crude extract of *F. Vulgare* has shown Anxiolytic activity. The presence of poly-estrogen is a leading cause of pharmaceutical manipulation of *F. Vulgare* as estrogen is used to cure deficiency syndromes. Estrogen is involved in anxiety reducing cycle via GABA-A receptor. Anxiolytic effect was inhibited by Tamoxifen and Picrotoxin. Experimental results have proposed that *F. Vulgare* has capacity to reduce stress and enhance memory in rats which revealed that *F. Vulgare* is multifunctional herb used to treat stress related diseases.³

Memory protective potential:¹⁶ Many plants are utilized to boost intelligence and memory. Out of these plants, *F. Vulgare* is also a well-known plant used to speed up the memory. Amnesiac rats were selected to analyze the effect of *F. Vulgare* extract. The results shown that memory enhancement was observed by the implementation of extract of *F. Vulgare*. Moreover, the effect of *F. Vulgare* extract was investigated in mice for neurotropic factor and anti-acetylcholinesterase. The findings showed that fennel extract suppress the liberation of acetylcholinesterase. On the basis of this study it was proposed that dementia and Alzheimer can be cured by the fennel.³



Figure 1: *Foeniculum Vulgare* (a) Leaf (b) Flowers (c) Seeds²

DISCUSSION

Estrogenic activity, gastro protective activity, hepatoprotective activity, antidiabetic activity, cardiovascular and lipid activity, antithrombotic activity, antioxidant activity, anti-inflammatory activity, anti-bacterial activity, anti-anxiety potential, memory protective potential and more. It is rich in saponins, flavonoids, cardiac glycosides, sterols, triterpenes, coumarins and volatile oils. Additionally it contains

calcium, potassium, sodium, iron, phosphorous, thiamine, riboflavin and niacin. This review discussed in detail its ethnobotanical description, habitat, phytochemical constituents, pharmacological activities. In Unani system of medicine it is being used since *Foeniculum vulgare* commonly known as “*Saunf*”, “Fennel” is an easily available and cost effective herb which is being used since centuries to treat various ailments. Its pharmacological actions centuries to treat digestive related problems, as diuretic and emmenagogue, to improve eyesight, in respiratory disorders, in healing wounds, kidney stone, diabetes, galactagogue, reproductive and endocrine system disturbances. However, on *garm mizaj* persons it may cause headache.

CONCLUSION

Fennel is an easily available and cost effective drug with various medicinal uses. However, further clinical trials and metaanalysis are required to prove its efficacy and therapeutic applications in different ailments.

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